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Isotope measurements on carbonatite complexes and komatiites can provide information on the geochemical character and geochemical evolution of the mantle, including sub-continental mantle. Measurements on young samples establish the validity of the method. These are based on Sr, Nd and Pb data from the Tertiary-Mesozoic Gorgona komatiite (1, 2) and Sr and Pb data from the Cretaceous Oka carbonatite complex (3, 4). In both cases the data describe a LIL element-depleted source similar to that observed presently in MORB.

Carbonatite data have been used to study the mantle beneath the Superior Province of the Canadian Shield one billion years (1 AE) ago. The framework for this investigation was established by Bell et al. (3) who showed that large areas of the province appear to be underlain by LIL element-depleted mantle ($^{87}Sr/^{86}Sr = 0.7028$) at 1 AE ago. Additionally Bell et al. found four complexes to have higher initial Sr ratios ($^{87}Sr/^{86}Sr = 0.7038$), which they correlated with less depleted (bulk earth?) mantle sources, or possibly crustal contamination.

We have determined Pb isotope relationships in four of the complexes studied by Bell et al. In favorable cases the carbonates from the complexes yield negligible in situ radiogenic Pb corrections ($\mu = 0.01 - 2$), allowing accurate determination of initial ratios. Initial ratios for six samples from three of the complexes with 0.7028 initial Sr ratios (Firesand, Prairie Lake, Killala) plot along a regression line given by $^{207}Pb/^{204}Pb = 0.128\ ^{206}Pb/^{204}Pb + 13.186$, with $^{206}Pb/^{204}Pb$ varying from 16.48 to 17.08. The data plot distinctly below crustal Pb evolution curves as given, for example, by Stacey and Kramers (5). The slope of the regression line, 0.128, differs significantly from the value expected from contamination with 1.0 AE Pb (0.0725) or 2.7 AE Pb (0.185). The carbonatite regression line plots to the left of the modern MORB regression line and has a slightly greater slope, apparently describing Pb isotope relationships for a billion-year-old MORB-like mantle source. The Pb and Sr data agree in suggesting that LIL element-depleted mantle existed beneath large areas of the Superior Province one billion years ago as far inland as the present-day Lake Superior region. Pb data from a fourth complex (Lake Nemegosenda, $^{87}Sr/^{86}Sr = 0.7038$) plot above the crustal Pb evolution curve, and agree with the Sr data in indicating either crustal contamination, or origin in more LIL-enriched mantle.

In contrast to the above results, isotopic data from 2.7 AE rocks of the Superior Province suggest that depleted mantle was of limited extent, and not sufficiently aged to have acquired an isotopic signature at that time. Sr data from the alkaline complex at Poohbah Lake (3) plotted nearly in the "bulk earth" field in a Sr evolution diagram ($^{87}Sr/^{86}Sr = 0.7012$) rather than below the field as in the case of the Oka and most of the billion year old complexes. Zindler et al. (6) showed that initial $^{143}Nd/^{144}Nd$ ratios in 2.7 AE komatiites and tholeiites of Munro Township, Albitibi District plot on the chondrite evolution curve at 2.7 AE, rather than above the curve as is observed for rocks from depleted mantle, e.g., MORB.

More recently, a Pb isotope study has been started on rocks from Munro Township (2). Sampling to date includes komatiite, tholeiite and sulfide ores. The komatiites are taken to represent mantle isotope relations, while the ores should characterize crustal isotopic compositions. When the data are plotted in a $^{207}Pb/^{204}Pb$ - $^{206}Pb/^{204}Pb$ diagram (Fig. 1) they closely fit an isochron giving an age of 2.65 AE. Statistical analysis of the regression line yields a Y axis intercept of 12.101 ± 0.035, a deviation within the 2σ

errors of the individual $^{207}Pb/^{204}Pb$ ratio measurements. This agreement is taken to indicate that all members of the suite have nearly identical age and initial Pb isotope ratios. The Pb data thus appear to be consistent with the SR data from Poohbah Lake and Nd data from Munro Township in failing to identify a LIL depleted mantle source for the komatiites and tholeiites 2.7 AE ago. An analogous case for Pb isotopic data from the Fennoscandian Shield of Finland was given by Vidal et al. (7), with the exception that the Finland regression line is systematically displaced above the Munro Township line, as shown in Fig. 1. The Finland suite includes granitic rocks that plot along the isochron with the komatiites and tholeiites. The only granitic Pb isotope data from the Abitibi District available so far are given in an abstract by Gariepy et al. (8), who report "large" variations in $^{207}Pb/^{204}Pb$ ratios in unmetamorphosed plutons. The contrast between the granite and ore data may indicate that the ores average out differences between individual plutons. Further isotopic studies of Pb are underway in the granitic rocks from Munro Township.

Although evidence for depleted mantle has been observed in Nd data in 3.5-3.8 AE rocks in other shield areas, Nd, Sr and Pb data suggest that depleted mangle originated ca. 2.7-3.0 AE ago in several areas beneath the Superior Province in the Canadian Shield. The relative abundance of depleted mantle on a world-wide basis in Archaean time remains to be definitively answered in future work.

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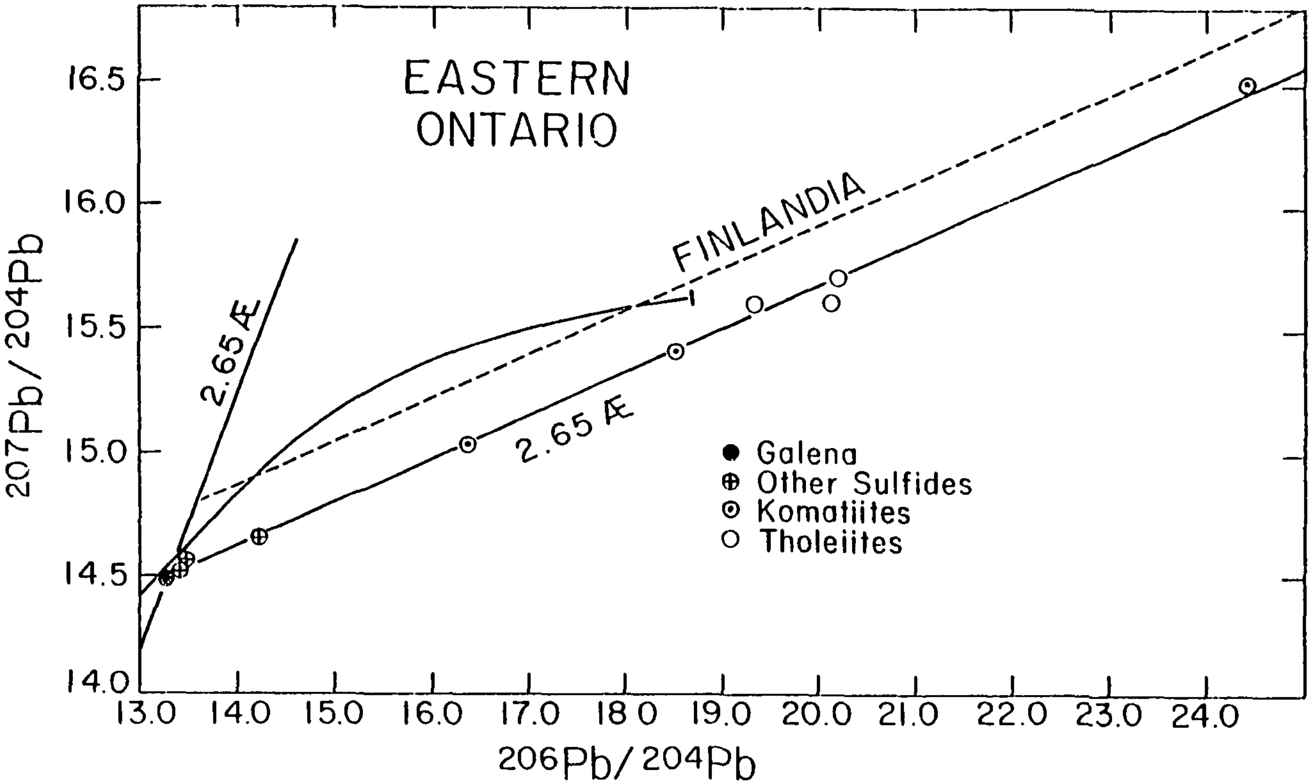

Figure 1. Pb isochron diagram for eastern Ontario samples. The dashed line is the regression line described by the Finnish data of Vidal et al. (7)